MULTIMEDIA UNIVERSITY®

STUDENT ID NO

MULTIMEDIA UNIVERSITY

FINAL EXAMINATION

TRIMESTER 2, 2017/2018

PME0016 – MECHANICS

(Foundation in Engineering - All Sections / Groups)

9 MARCH 2018
3.00 P.M – 5.00 P.M
(2 Hours)

INSTRUCTIONS TO STUDENTS

1. This question paper consists of 8 pages.
2. Answer **ALL** questions. The distribution of the marks for each question is given.
3. Write all your answers in the Answer Booklet provided.
4. All necessary workings **MUST** be shown.

QUESTION 1 (10 Marks)

a) An object is acted upon by only two forces that are of equal magnitude and oppositely directed. Is the object necessarily in static equilibrium? Explain.

[2 marks]

b) A board weighing 100 N sits across two sawhorses, as shown in **Figure Q1(b)**. What are the magnitudes of the normal forces acting on the board?

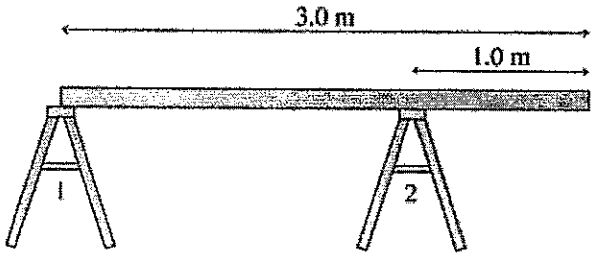

Figure Q1(b)

[3 marks]

c) A woman weighing 600 N lies on a 2.5 m long, 60 N reaction board with her feet over the pivot as in **Figure Q1(c)**. The scale on the right reads 250 N.

(i) Draw the free body diagram of the board.

[2 marks]

(ii) What is the distance d from the woman's feet to her center of gravity?

[3 marks]

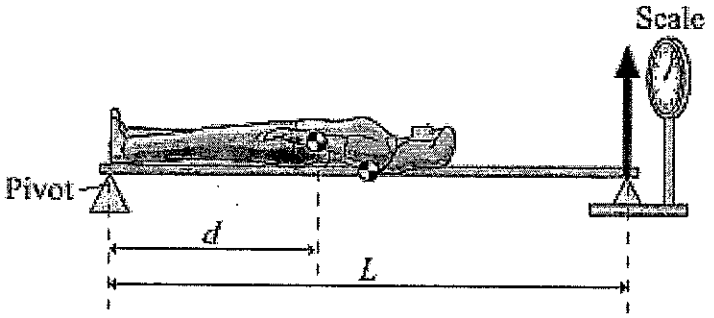

Figure Q1(c)

Continued...

QUESTION 2 (10 MARKS)

a) A 1500 kg car is approaching the hill as shown in **Figure Q2(a)** at 10 m/s when it suddenly runs out of gas.

(i) Can the car make it to the top of the hill if the velocity of the car is 0 m/s when it approaches the hill? Explain your answer by using the energy conservation theory.

[3 marks]

(ii) If your answer is yes, what is the car's speed after coasting down the other side?

[2 marks]

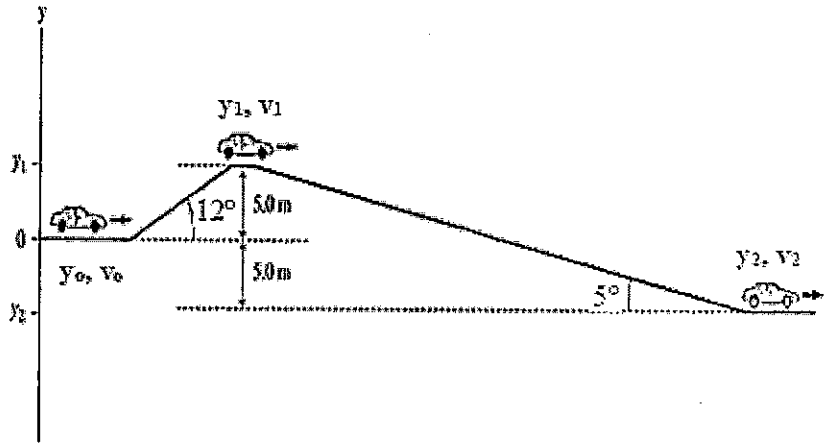

Figure Q2(a)

b) A spring gun shoots out a plastic ball at speed v. The spring is then compressed twice the distance it was on the first shot.

(i) By what factor is the spring's potential energy increased? Explain.

[1 mark]

(ii) By what factor is the ball's speed increased? Explain.

[1.5 marks]

c) Figure **Q2(c)** below show a box sliding on a frictionless flat surface runs into a fixed spring, which compresses a distance x to stop the box. If the initial speed of the box were doubled, how much would the spring compress in this case?

[2.5 marks]

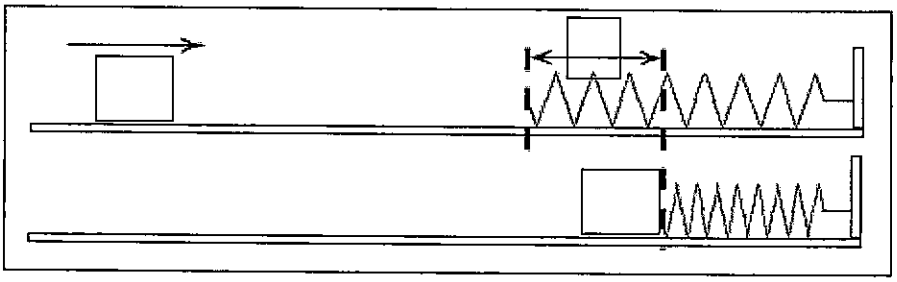

Figure Q2(c)

Continued...

QUESTION 3 (10 Marks)

a) If you are using a wrench to loosen a very stubborn nut, you can make the job easier by using a "cheater pipe". This is a piece of pipe that slides over the handle of the wrench, as shown in **Figure Q3(a)**, making it effectively much longer. Explain why this would help you loosen the nut.

[2 marks]

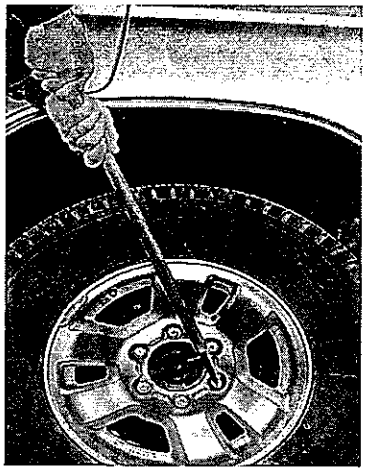

Figure Q3(a)

b) The angular acceleration of a wheel, as a function of time is, $\alpha = 5.0t^2 - 8.5t$, where α is in rad/s^2 and t is in seconds. If the wheel starts from rest, determine

(i) angular velocity, ω

[1.5 marks]

(ii) the angular position θ

[1.5 marks]

(iii) evaluate ω and θ at t = 6s

[2 marks]

c) To throw a discus, the thrower holds it with a fully outstretched arm. Starting from rest, he begins to turn with a constant angular acceleration, releasing the discus after making one complete revolution. The diameter of the circle in which the discus moves is about 1.8 m. If the thrower takes 1.0 s to complete one revolution, starting from rest, what will be the speed of the discus at release?

[3 marks]

Continued...

QUESTION 4 (10 MARKS)

a) In **Figure Q4(a)**, A and B are rectangular tanks full of water. They have equal heights and equal side lengths, but different widths.

(i) Compare the forces and pressure the water exerts on the bottoms of the tanks. Explain.

[1.5 marks]

(ii) Compare the forces and pressure the water exerts on the sides of the tanks. Explain.

[1.5 marks]

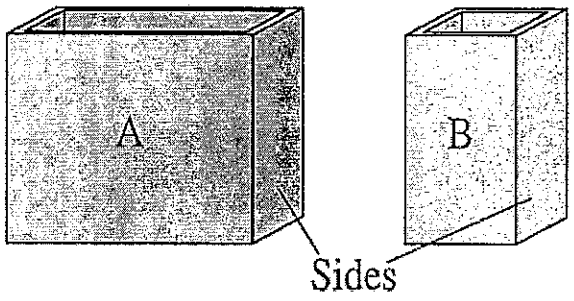

Figure Q4(a)

b) The container shown in **Figure Q4(b)** is filled with oil. It is open to the atmosphere on the left. Given that $\rho_{oil} = 900 kg/m^3$.

(i) What is the pressure at point A?

[1.5 marks]

(ii) What is the pressure difference between points A and B? Between points A and C?

[2 marks]

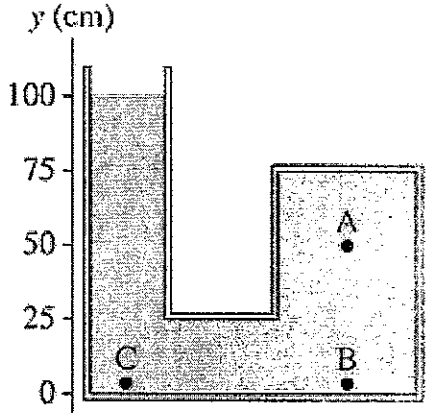

Figure Q4(b)

Continued...

c) The two 60 cm diameter cylinders in **Figure Q4(c)**, closed at one side, open at the other, are joined to form a single cylinder, then the air inside is removed.

(i) How much force does the atmosphere exert on the flat end of each cylinder?

[1.5 marks]

(ii) Suppose the upper cylinder is bolted to a sturdy ceiling. How many 100 kg football players would need to hang from the lower cylinder to pull the two cylinders apart?

[2 marks]

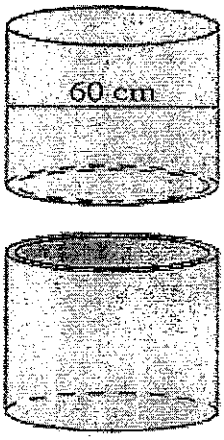

Figure Q4(c)

QUESTION 5 (10 Marks)

A classic children's toy consists of a wooden animal suspended from a spring. If you lift the toy up by 10 cm and let it go, it will gently bob up and down, completing 4 oscillations in 10 seconds.

(i) Describe what an oscillatory motion is.

[1 mark]

(ii) Sketch a sinusoidal graph that shows the toy's position from the equilibrium position for first two cycles of the oscillation.

[3 marks]

(iii) What is the oscillation frequency?

[1.5 marks]

(iv) When does the toy reach its maximum speed, and what is its speed value?

[1.5 marks]

(v) What are the position and velocity at $t = 4.0$ s after you release the toy?

[3 marks]

Continued...

APPENDIX I:

LIST OF PHYSICAL CONSTANTS

Electron mass,	m_e	=	9.11×10^{-31} kg
Proton mass,	m_p	=	1.67×10^{-27} kg
Neutron mass,	m_n	=	1.67×10^{-27} kg
Magnitude of the electron charge,	e	=	1.602×10^{-19} C
Universal gravitational constant,	G	=	6.67×10^{-11} N.m^2 / kg^2
Universal gas constant,	R	=	8.314 J/ mol.K
Hydrogen ground state,	E_0	=	13.6 eV
Boltzmann's constant,	k_B	=	1.38×10^{-23} J/K
Compton wavelength,	λ_c	=	2.426×10^{-12} m
Planck's constant,	h	=	6.63×10^{-34} J.s
		=	4.14×10^{-15} eV.s
Speed of light in vacuum,	c	=	3.0×10^8 m/s
Rydberg constant,	R_H	=	1.097×10^7 m^{-1}
Acceleration due to gravity of earth,	g	=	9.80 m/s^2
1unified atomic mass unit,	1 u	=	931.5 MeV/c^2
		=	1.66×10^{-27} kg
1 electron volt,	1 eV	=	1.60×10^{-19} J
Avogadro's number,	N_A	=	6.022×10^{23} mol^{-1}
Threshold of intensity of hearing,	I_0	=	1.0×10^{-12} W/m^2
Coulomb constant,	$k = \frac{1}{4\pi\varepsilon_0}$	=	9.0×10^9 N.m^2 /C^2
Permittivity of free space,	ε_0	=	8.85×10^{-12} C^2/N.m
Permeability of free space,	μ_0	=	$4\pi \times 10^{-7}$ T.m/A
1 atmosphere pressure,	1 atm	=	1.0×10^5 N/m^2
			1.0×10^5 Pa
Wein's displacement constant		=	0.2898×10^{-2} m.K
Speed of Sound in Air		=	343 m/s
Refractive index of air/vacuum	n	=	1.0
Earth: Mass,	M_E	=	5.97×10^{24} kg
Radius (mean),	R_E	=	6.38×10^3 km
Moon: Mass,	M_M	=	7.35×10^{22} kg
Radius (mean),	R_M	=	1.74×10^3 km
Sun: Mass,	M_S	=	1.99×10^{30} kg
Radius (mean),	R_S	=	6.96×10^5 km
Earth-Sun distance (mean),		=	149.6×10^6 km
Earth-Moon distance (mean),		=	384×10^3 km

Continued...

APPENDIX II:

LIST OF FORMULAS IN MECHANICS

$y = kx^n$ $\frac{dy}{dx} = knx^{n-1}$	$\sin\theta = \frac{\text{opposite}}{\text{hypotenuse}}$	$\cos\theta = \frac{\text{adjacent}}{\text{hypotenuse}}$	$\tan\theta = \frac{\text{opposite}}{\text{adjacent}}$

$v = v_o + gt$ $\quad y - y_o = v_o t + \frac{1}{2}gt^2$ $\quad v^2 = v_o^2 + 2g(y - y_o)$

$y - y_o = \left(\frac{v_o + v}{2}\right)t$

$a_c = \frac{v^2}{r}$ $\quad F_g = G\frac{m_1 m_2}{r^2}$ $\quad U_g = -G\frac{m_1 m_2}{r}$ $\quad T^2 = K_s r^3$

$\tau = r \times F$ $\quad \sum\tau = \tau_{net} = I\alpha$ $\quad I = \sum mr^2$ $\quad v = r\omega$

$L = r \times p = I\omega$ $\quad K = \frac{1}{2}I\omega^2$

$T_s = 2\pi\sqrt{\frac{m}{k}}$ $\quad T_p = 2\pi\sqrt{\frac{l}{g}}$ $\quad T = \frac{2\pi}{\omega} = \frac{1}{f}$

$x = A\cos\omega t$ $\quad x = A\sin\omega t$

$v = -\omega A\sin\omega t$ $\quad v = \omega A\cos\omega t$

$a = -\omega^2 A\cos\omega t$ $\quad a = -\omega^2 A\sin\omega t$

$v = \frac{\Delta x}{\Delta t}$ $\quad a = \frac{\Delta v}{\Delta t}$

$v = v_o + at$ $\quad x - x_o = v_o t + \frac{1}{2}at^2$ $\quad v^2 = v_o^2 + 2a(x - x_o)$

$x - x_o = \left(\frac{v_o + v}{2}\right)t$

$W = mg$ $\quad \sum F = F_{net} = ma$ $\quad f_s \le \mu_S F_N$ $\quad f_k = \mu_K F_N$

$p = mv$ $\quad \sum F = \frac{\Delta p}{\Delta t}$

$m_1u_1 + m_2u_2 = m_1v_1 + m_2v_2$ $\quad m_1u_1 + m_2u_2 = (m_1 + m_2)v$ $\quad P = \frac{W}{t} = \frac{E}{t} = \frac{Fd}{t} = F\bar{v}$

$K = \frac{1}{2}mv^2$ $\quad PE_s = \frac{1}{2}kx^2$ $\quad F_s = -kx$ $\quad PE_G = mgy$

End of Page.